CHAPTER 2

PC 99 Design Initiatives

This chapter presents additional information about the key PC 99 design initiatives. Complete references for specifications and implementations discussed in this chapter are presented in Chapter 3, "PC 99 Basic Requirements."

Contents

Wireless Design Issues

This section introduces the technical issues and PC 99 directions for infrared (IR) solutions and identifies the emerging industry standards that might impact radio frequency (RF) solutions).

Capabilities of IrDA Standard Solutions. IR solutions for PC 99 designs are based on the communication standards developed by the Infrared Data Association (IrDA). The two IR solutions based on IrDA-ratified standards are IrDA Data and IrDA Control (also known as IrBus). A third solution is represented by a variety of legacy unidirectional remote control IR protocols. The following summarizes the capabilities of each of these solutions:

- IrDA Data devices perform point-to-point, bi-directional, narrow cone, high-speed (115 Kb/s to 4 Mb/s), short-range (3 to 6 feet) reliable bulk transfers. The IrDA Data protocol enables file transfers over ad-hoc networks; for example, file transfers among laptop, Personal Digital Assistant (PDA), and desktop systems, and other non-PC devices such as cameras.
- IrDA Control (IrBus) enables simultaneous low-speed (75 Kb/s per device), low latency, relatively long range (up to 20 feet), wide cone, reliable communications among multiple devices, such as bi-directional keyboards, mice, multimedia, and game controls. An IrDA Control specification was approved in early 1998 by IrDA and the first products are expected to ship in late 1998.
- Legacy remote control IR protocols are in wide use to control consumer-electronics devices such as televisions, VCRs, CD players, and so on. No standard is provided for legacy remote control devices by IrDA or any other standards body. PC systems designed to control such devices or to be controlled by existing IR remote controls must accommodate the lack of standards for these unidirectional protocols by adopting a universal consumer-IR approach.

Advantages of IrDA Protocols. Although system designers can choose to support one or more of the three IR solutions, designers are encouraged to use the IrDA Data and Control protocols. For many applications, the IrDA Control protocol has some significant advantages over the legacy remote control protocols that give it the potential to become a world-wide standard:

- IrDA Control is bi-directional, which enables “smart” control applications that both download and upload information.
- IrDA Control supports up to eight peripherals simultaneously, using a combination of Time Division Multiple Access (TDMA) and Packet Reservation Multiple Access (PRMA), based on a statistical slotting algorithm.

Because a separate dongle does not have to be provided for each control device, use of the IrDA Control protocol is of particular advantage to OEMs who want to bundle multiple wireless control devices with their systems, for example, a mouse, a keyboard, and two game pads.

PC 99 Directions for IR. Interoperability is a problem among all three of the IR protocols. Although future technology advances might allow some consolidation of IR transceiver ports, this is not expected for 1999–2000. Therefore, a PC 99 system must provide a separate transceiver for each protocol it supports. These transceivers must be physically isolated from each other.

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If a PC 99 system is advertised as supporting all three IR solutions, the system must provide three physically isolated transceivers, one for each protocol, and it must expose each transceiver to the operating system. For example, to provide physical isolation, the IrDA Control transceiver could be placed on the front of the system, and the IrDA Data and legacy remote control transceivers could be placed on different sides of the system.

If a PC 99 system is advertised as supporting two of the protocols, for example, IrDA Data and IrDA Control, the system must provide two physically isolated transceivers, one for each protocol.

Many manufacturers are implementing integrated IR solutions for mobile PCs. Various form-factor and environmental issues have limited the adoption of wireless solutions for desktop PCs, including receiver placement in the office environment and limiting conflicting device signals. Universal Serial Bus (USB) IR bridging devices or hubs are expected to help resolve many of physical placement issues for desktops. A USB working group is developing guidelines on how USB will interface with both IrDA Data and IrDA Control devices, with first products expected to ship near the end of 1998.

Manufacturers must incorporate Fast IR solutions as soon as possible; particularly for mobile system designs. Fast IR transmits and receives data at speeds of 1.152 megabits per second (Mb/s) and 4.0 Mb/s. Fast IR includes design implementations that improve usability. Manufacturers must also include Serial IR (SIR) backward compatibility in their Fast IR solutions.

Emerging RF Standards. New standards groups for RF communications in the consumer market are emerging. In particular, the HomeRF Working Group (HRFWG), which is comprised of computer, telecommunications, and consumer electronics companies, is developing an interoperable RF common air interface called Shared Wireless Access Protocol (SWAP). Manufacturers should be aware of the SWAP specification effort, which will be recommended in future Consumer PC systems as a standard RF connection. Information is available on the HRFWG web site at http://www.homerf.org.

Video and Broadcast TV Design Issues

New technologies are becoming available that integrate the PC with television, making the PC more compelling for new audiences and new uses. These new technologies, which are built into Windows 98 and Windows NT 5.0, consist of broadcast components that allow PCs to receive television programming, data services, and new forms of entertainment that blend the two. These technologies are enhanced in the operating system with new user-interface elements appropriate for use on large-screen display devices such as a progressively scanned display or a television monitor.

The broadcast and video technologies in Windows 98 and Windows NT 5.0 are based on industry standards such as MPEG-2 Win32, ActiveX, and DirectX, and they are also built on current and emerging standards for broadcast networks and Internet protocols, enabling IP Multicast as a point-to-many networking standard for network traffic.

Broadcast network capabilities provide a transmission infrastructure that can support services such as automatic software and file updates. Broadcast technologies enable new applications and business opportunities such as:

- New types of programming that combine the PC, television, and the Internet.
- Multimedia Internet content delivered by broadcast networks and stored locally on the PC, reducing the Internet bandwidth bottleneck and improving the overall user experience.
- Secure, billable, and scaleable data services such as subscription services for software, electronic news, and entertainment, encouraging creation of new business models.

Hardware manufacturers can find new business opportunities in the convergence of consumer electronics and personal computing. This convergence also offers opportunities for cross-industry collaboration in creating new products and services.

The aim of the PC 99 guidelines is to ensure that PCs and related computer devices can do everything the TV, VCR, set-top box, and hi-fi system can do. This new set of capabilities requires careful design decisions for adding new features to the PC without taking away anything from the known features of the traditional TV and other devices. In particular, the assessment of picture quality includes image clarity, smooth resizing, and precision of frame delivery. The challenge for the designer is to ensure that the PC meets or exceeds the video and audio quality of traditional consumer appliances. Particular emphasis will be placed on checking that rendering is accurate for the highest motion content scenes.

Important design issues addressed in the PC 99 guidelines that relate to integrating video and broadcast TV capabilities with the PC include the following:

- Increased quality of video capture and playback, including an absence of banding related to poor scaling methods.
- Low-latency video delivery, displaying video from both internal and external video devices.
- Support for receiving digital TV broadcasts.
- Increased use of multiple screens and their associated display controllers. This allows a PC to run a word processing application in one room, while simultaneously supplying a TV, located in another room, with a DVD movie or TV content.
- Separation of “receiver” functions from “display” functions. The two will be linked by software running on the host processor. This allows different elementary streams such as MPEG video, audio, and data to be sent to the appropriate subsystems within the PC. It also prepares the way for the long range goal of a video home network.
- Introduction of Device Bay as a way of implementing TV receiver modules. This is in addition to the use of PCI adapters and external receiver boxes, which are also acceptable implementations.
- Required use of Microsoft DirectShow™ for video playback.

Notice that support for video playback under Windows 98 and Windows NT 5.0 is provided only under DirectShow, as described in the following section. No functionality will be added to Video for Windows in any future version of Microsoft operating systems.

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DirectX and DirectShow

The Microsoft DirectX® foundation provides low-latency interfaces to media hardware. Previously, the primary market focus for these technologies was entertainment titles, but these APIs also provide a solid foundation for the media services required for Internet applications. In addition, they also provide the media foundation for a broad range of productivity applications, enabling high-performance media with hardware acceleration.

Microsoft DirectDraw® is the Windows system component that allows direct manipulation of video display memory, hardware block transfers (bit-blters), hardware overlays, and page flipping. DirectDraw performs the common functions required by both hardware and software emulation implementations while maintaining compatibility with the Windows Graphics Device Interface (GDI). This provides compatibility with existing Windows applications and device drivers. The user will experience the highest quality performance when using new hardware that provides built-in DirectDraw acceleration and rendering capabilities.

Microsoft Direct3D® is a DirectX technology that provides access to hardware acceleration for 3-D rendering. Some basic and general 3-D capabilities will become pervasive in entertainment software by the end of 1999. These capabilities should be provided in all graphic cards to improve the performance of 3-D games, business graphics, Internet 3-D file viewing (virtual reality modeling language, or VRML), and professional 3-D applications.

DirectShow (formerly known as ActiveMovie™) provides access to hardware acceleration for MPEG-1 playback, which will become increasingly important for high-performance video in the context of games, Internet content viewing, computer-based training, and desktop video conferencing. Some PC 99 hardware requirements ensure support for video playback on all PCs running Windows operating systems. DirectShow is required to support video playback under the PC 99 guidelines.

DirectSound® provides a low-level and high-performance audio API, including 3-D sound spacialization (DirectSound3D) and MIDI (DirectMusic™) APIs.

DirectInput® provides a low-level and high-performance input device API to support keyboards, mice, joysticks, and so on. DirectPlay® provides a collaborative communications layer.

DirectMusic is described in “Audio Design Issues” later in this chapter.

Audio Design Issues

This section addresses the key design issues for audio.

Basic vs. Advanced Audio. The basic audio requirements defined in these guidelines identify the baseline operating system and hardware audio support available for existing and emerging multimedia applications. They are also designed to ensure that a minimum audio capability exists across a majority of platforms.

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The advanced recommendations describe additional software and hardware features beyond the minimum requirements. These recommendations support vertical applications and provide scalability above the baseline audio capabilities by offering higher compatibility, performance, concurrency, or quality.

WDM and PC Audio. One key to the successful advancement of audio in the PC is WDM Audio class support. The architecture performs all audio processing in kernel mode, which significantly improves latency.

WDM also provides a more complete architecture than previous generations. Code common to all audio hardware on a given bus is now part of the operating system, making for faster development with more consistent results.

External Digital Audio. USB and IEEE 1394 provide excellent mechanisms for delivering digital audio to external peripherals for high-quality conversion (greater than 85 dB dynamic range) to and from analog. In the near term, the popularity of USB makes it a natural choice. In the long term, the consumer-electronics industry envisions IEEE 1394 transporting audio and video among many devices in a simple, high-performance manner.

PC Audio Transitions

For the foreseeable future, audio in the PC will continue to offer a wide array of possibilities. One notable trend is the movement toward solutions that use a hybrid of host-based and device-based audio data processing. Current and future versions of the DirectX APIs, including DirectSound, DirectSound3D, and DirectMusic will expand the degree of support for all styles of audio solutions, from host-based to fully hardware-based.

As the PC is increasingly called upon to play the part of a consumer-electronics device, for example, video-disc playback, sound quality becomes more important. A number of initiatives are underway to achieve optimal sound quality. Another implication of this trend is the need for simpler operation and hardware configuration.

The state of audio functionality is far from stagnant, presenting a challenge for the industry to maximize performance and simplicity, and to add more advanced features. The shift to higher quality and support for external digital connectivity will not happen overnight. One objective of the PC 99 audio guidelines is to facilitate the transition over the next few years. Four audio applications merit more detailed discussion and are described in the following sections:

- CD and DVD media playback
- Scalable music synthesis for games and multimedia
- Scalable audio for 3-D games
- Full-duplex H.323/H.324 video and audio conferencing

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CD and DVD Media Playback

WDM audio supports the following features for CD and DVD media playback under Windows 98 and Windows NT 5.0:

- A kernel-mode CD driver that emulates MSCDEX commands and implements reading, parsing, and streaming of Red Book CD digital audio to the kernel-mode WDM system-wide mixer at 16-bit stereo 44.1 kHz.
- A Universal Disk Format (UDF) DVD file reader, splitter, and navigator that provides access for DirectShow clients to separate video and audio streams.
- A kernel-mode, system-wide software mixer, which supports DirectSound, DirectShow, and WINMM clients, plus kernel-mode WDM filters, including Red Book CD and MIDI drivers. The architecture provides the ability for algorithms from any vendor to decode the DVD audio and it supports mixing at 16-bit stereo 48 kHz.
- Flexible control of the output destination. The WDM drivers can send the master 16-bit 44.1-kHz or 48-kHz, or other format output to a PCI, USB, or IEEE 1394 audio device. Support is also provided for redirecting the PCI-device final-mix output to USB speakers.

As defined in Chapter 17, “Audio Components,” baseline PC 99 audio hardware support for CD and DVD media playback requires that the built-in or external audio codec support playback of 16-bit stereo PCM data at either a 44.1-kHz or 48-kHz sample rate.

For MPEG content, the system designer might choose to include optional DirectShow or WDM kernel-mode streaming filter components, or hardware that can provide the following capabilities:

- Greater than 85-dB dynamic range codec audio quality to meet performance requirements of the consumer-electronics market
- Software or hardware Dolby AC-3 or MPEG-2 multichannel decode and downmix to stereo at 16-bit 48 kHz
- Software or hardware MPEG-1 layer-2 stereo at 16-bit 32, 44.1, or 48 kHz
- Software or hardware support for up to 24-bit 96-kHz linear PCM (LPCM) data, down-converted to 16-bit 48 kHz

Scalable Music Synthesis for Games and Multimedia

DirectMusic is a new set of core services featuring:

- An interactive music engine that enables the PC to generate a highly customized musical accompaniment capable of following on-screen action with precision.
- An open architecture that provides custom sound sets that can be played back on music products from any manufacturer.
- MIDI APIs that provide much better timing and musical stream control.

DirectMusic will be included with Windows NT 5.0 and will be available as an add-on for Windows 98 and Windows 95. For more information on DirectMusic and the interactive music architecture, see http://www.microsoft.com/directx/. The details of DirectMusic of interest to hardware manufacturers include:

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- An API that allows applications to manage DLS files and download the relevant instruments to hardware or software synthesizers. For information, see *DLS Specification, Version 1.0*, at http://www.midi.org.
- A software synthesizer to accommodate situations where no hardware capability exists. The architecture allows third-party software synthesizers to connect with DirectMusic.
- A new timing model with a kernel-mode sequencer that allows the components to track either a system clock or sample clock on the audio hardware. There is also a provision for the synthesizer to report latency, subsequently receiving MIDI data with the appropriate advanced-scheduling. As a result, hardware and software synthesizers will play completely in sync.
- A decompression model that enables developers to encode DLS files using any of the ACM codecs. The system performs real-time decompression of the file before making it available to the hardware or software synthesizer.

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Because of the availability of a software synthesizer, PC 99 does not require hardware to support DirectMusic. To create a more efficient implementation with higher performance, the hardware designer must address the following trade-offs:

- CPU utilization versus hardware cost. Hardware synthesizers typically consume fewer system resources during playback of a DirectMusic application.
- Sound quality versus hardware cost. Hardware synthesizers typically operate at a higher master sample rate and use higher-order interpolation than software synthesizers.

Scalable Audio for 3-D Games

The APIs provide standard interfaces for applications to use one or more streams of 3-D-positioned audio. The DirectSound3D Hardware Emulation Layer (HEL) enables optimal configuration based on CPU performance and installed hardware, and enables three levels of 3-D support:

- Software-simulated 3-D using simple inter-aural delay processing
- True HRTF 3-D filtering optimized for the media-enhancement instruction set in the central processor
- Hardware acceleration

WDM audio supports the following features specifically for 3-D games under Windows 98 and Windows NT 5.0:

- Software emulation of legacy hardware to support MS-DOS–based games in Windows 98. WDM drivers, which run in kernel mode, provide virtual Sound Blaster Pro, MPU 401, and legacy joystick interfaces.

  Direct access to audio hardware has never been supported in Windows NT; WDM audio services for Windows NT do not include support for MS-DOS–based games.
- A standard interface for the application to provide multiple streams of 3-D–positioned audio. DirectSound3D supports hardware acceleration, software-simulated 3-D using inter-aural delay processing, and true HRTF 3-D processing. The architecture supports optimal configuration based on CPU performance and installed hardware.
- A wave-table MIDI synthesizer, existing entirely in kernel-mode software. This provides 32 voices of music synthesis with 22.05-kHz output. DirectShow, DirectMusic, WINMM, and virtual MPU 401 can use the synthesizer functions. The architecture supports optimal configuration based on CPU performance and installed hardware.
- A high-quality kernel-mode software SRC capability, which converts data streams, including composite mixes of all 11.025-kHz or 22.05-kHz sources, to the final output mix format, typically 16-bit 44.1 kHz. General SRC support includes other rates.

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- A kernel-mode system-wide software mixer, which supports DirectSound, DirectShow, and WINMM clients, plus kernel-mode WDM filters, including Red Book CD and MIDI drivers. The mixer implements highly optimized, same sample rate PCM mixing at 8-bit or 16-bit 11.025, 22.05, 44.1, and 48 kHz. General mixing support includes other formats).
- Flexible control of the output destination. The WDM drivers can send the master 16-bit 44.1-kHz, 48-kHz, or other format output to a PCI, USB, or IEEE 1394 audio device. Support is also provided for redirection of PCI-device final-mix output to USB speakers.

As defined in Chapter 17, "Audio Components," the minimum PC 99 audio hardware support necessary for 3-D games is built-in or external audio codec support for playback of 16-bit stereo PCM data at a 44.1-kHz sample rate.

The system designer might choose to include the following optional software or hardware to provide additional capabilities:

- Optimized software or digital-ready hardware acceleration for higher quality or concurrency DLS wave-table MIDI synthesis, with associated mixing and SRC support.
- Optimized software or digital-ready hardware acceleration for higher concurrency HRTF 3-D positional audio, with associated mixing and SRC support.

Full-Duplex H.323/H.324 Video and Audio Conferencing

WDM audio supports the following features for full-duplex video and audio conferencing under Windows 98 and Windows NT 5.0:

- Native 32-bit support for simultaneous audio input and output, not dependent on 16-bit MMSYS components.
- Input and output position reporting mechanisms for synchronization of speaker and microphone streams, accurate to 1 ms or better.
- WDM Stream class driver that provides access to acoustic echo cancellation (AEC) reference interfaces supported by hardware codecs.

As defined in Chapter 17, "Audio Components," baseline PC 99 audio hardware support for H.323/H.324 video and audio conferencing requires full-duplex audio capability. The system designer might choose to include optional hardware to provide hardware AEC references for echo cancellation filtering.

Modem Design Issues

The Windows 98 and Windows NT operating systems and Win32-based applications use data, fax, voice, and voice/data integration features in modems. The fundamental design principle for compatibility with Windows and Windows NT is for the device to be supported by the Universal Modem Driver (Unimodem), which uses INF files to characterize the behavior of a device. Unimodem requirements are defined in the Windows Modem Developers Kit (MDK), available at http://www.microsoft.com/hwdev/.

PC 99 guidelines are designed to address the following issues:

- Providing higher-speed dial-up access based on standardized pulse-code modulation (PCM) modems, based on ITU V.90.
- Augmenting modem functions to support low-latency multimedia applications.
- Addressing persistent cost-of-ownership problems, particularly modem detection and installation, and Internet Service Provider (ISP) call failures.
- Migrating modem functions into the operating system to save costs and provide upgrade flexibility.

This section provides more information about the key design issues for modems.

Migrating to Higher Speeds with PCM Modems

ISP access is a driving force for modem use. PCM modems enable the highest possible download speeds from central sites that are digitally connected to the Public Switched Telephone Network (PSTN).

The ITU-T standard for PCM modems, V.90, was completed in February 1998. V.90 capabilities are a minimum PC 99 requirement for modems designed for desktop systems.

Supporting Low-Latency Multimedia Applications

The growth of the Internet, with web sites featuring real-time streaming sound and video, has meant an increase in the transport of natural data types such as voice and video across modem connections. The requirements imposed on modems for such data types are different from those related to simple file transfer. Specifically:

- Data integrity, of critical importance in file transfer operations, is less important for voice or video.
- Because digitized sound and video tend to be highly compressed already, the data compression capabilities of modems often go unused.
- Data latency, both average delay value and delay jitter, become quite important for natural data types, especially for interactive applications. Latency is a minor issue for file transfer, because the total transfer time for the file is usually far greater than the delay value.
- Interruptions in data flow for data pump retrains or rate renegotiations, which are benign to file transfers, are intolerable for natural data types.

To address the low-latency demands of multimedia applications, the V.42 and V.42 *bis* protocol layers in the modem can be disabled. This removes the large buffering delays and data-forwarding jitter associated with these protocols. The Synchronous Access Mode procedures defined in ITU-T Recommendation V.80 can be enabled as an alternative to V.42 and V.42 *bis* to support low-latency, bandwidth-efficient connections.

On V.34 connections, data interruptions related to retrains and rate renegotiations can be reduced by the use of the Seamless Rate Change (SRC) procedures defined in new Annex A/V.34 (1998). SRC allows the modem to adjust its speed to match line conditions without disturbing the flow of data.

Addressing Cost of Ownership for Modems

The two largest cost-of-ownership issues for modems are installation problems

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and operations problems related to creating connections. Plug and Play minimizes installation problems when correctly implemented. However, the explosion in ISP usage has increased the percentage of modem connections made on local calls, as opposed to long distance, and has highlighted operations problems on such connections. According to public studies, 16.2 percent of ISP access calls fail to connect, and ISPs are commonly spending six dollars per subscriber per month in technical support. Only a small percentage of access calls fail after the connection is made.

This failure rate is not acceptable. Elements needed to change this are:

- Impairments unique to local calls need to be included in industry-standard modem test suites, so that modem data pumps are designed and evaluated for such conditions.
- Modem and PSTN diagnostics must be implemented, so that the causes of field failures can be identified.
- Modems should be capable of being upgraded easily with revised code developed from the diagnostic feedback.
- Deterministic modem identification must be implemented so that upgraded modems still work.

TSB-37A is the industry-standard model of the North American PSTN, widely used for evaluating modem performance by simulating telephone connections. Iinvestigation by some of the regional Bell operating companies discovered that although TSB-37A does a good job simulating long-distance connections, it does not account for certain impairments specific to local calls that might affect modem performance.

TSB-37A is currently under revision; the revised standard, TSB-37B, will include accurate simulation of local connections. TSB-37B is expected to be completed in 1998, and its use should allow for a more accurate prediction of modem performance on local calls.

Microsoft, in consultation with leading ISPs and modem manufacturers, is developing a standard method for modems to report last-call statistics: the Unimodem Diagnostics command, or AT#UD, as described in the specification at http://www.microsoft.com/hwdev/respec/. This command can be used by Windows and ISP software to determine the reported last-call information which is essential to uncover problems in user modems, local phone loops, local offices, and ISP-side modems so that they can be diagnosed and fixed.

Requiring modem replacement as a solution is too costly for both the user and the manufacturer. Some manufacturers, such as those who make Windows-based modems, already make their modems with upgradable memory, allowing feature and fix upgrades for their customers. Easy upgradability for end users must become an industry-wide standard.

But even upgrades can pose hazards. For modems that do not support Plug and Play, the Windows Modem class installer reads a series of AT commands, implements a proprietary algorithm to generate a 32-bit ID, and uses that ID to match to the modem driver. Manufacturers might inadvertently change the responses that the Unimodem depends on for computing the unique Unimodem ID, such as AT+GM*x*, ATI, and other commands, leaving the user with a modem that is recognized as a “Standard Modem” instead of the actual modem name.

To address the detection problem, modem vendors are required to use bus-specific Plug and Play means to deliver the Compatible ID command, and they are encouraged to use standard methods to report accurate manufacturer and modem names. For information, see specifications for new Unimodem commands and related articles at http://www.microsoft.com/hwdev/hwdev/devdes/.

Migrating Functions to the Operating System with Windows Modems

A traditional modem has several functions implemented in hardware or firmware:

- Telephone network connection—connectors, transformers, relays, codec
- Digital signal processing—V.90, V.34, V.8 *bis*, dual-tone multifrequency (DTMF), voice processing, speakerphone echo cancellation, and so on
- Modem controller—AT command interpreter (V.250)
- Protocol stacks—V.42 error control, V.42 *bis* data compression

A Windows modem moves some of these functions into Windows drivers. A controllerless modem, also known as a host-based controller, is a modem that consists of a digital signal processor (DSP) without the usual microcontroller. The host CPU provides the AT command interpreter, modem control functions, V.42, and V.42bis implementation.

A software modem, also known as host-based signal-processing modem or pumpless modem, performs signal processing on the host microprocessor and implements the controller. The modem hardware consists only of a telephone-line interface, digital-to-analog converter (DAC), and analog-to-digital converter (ADC) circuitry such as an *Audio Codec '97 2.0* modem codec, plus a little bit more. However, the hardware does not contain a DSP or a microcontroller.

Advantages of software modems, in addition to cost savings, include the following:

- The design provides great flexibility for upgrading to new standards, engineering fixes, and so on.
- Separate data and control paths are available to the hardware.
- Data processing occurs in the CPU, where it fits.

  However, in many microcontroller-based modems, V.42 *bis* throughput is limited in some situations by available microcontroller processing power

Disadvantages of software modems include the following:

- CPU-based functions compete for resources with other uses, such as the operating system, applications, multimedia codecs, and so on.
- The design is dependent on a specific operating system environment in order to function. For example, a Windows modem does not function in the pre-boot environment or under real-mode MS-DOS.
- The implementation requires Windows-savvy code development to ensure that the modem drivers are well-behaved in the system and to ensure straightforward installation and operating system upgrades.

Controllerless and software modems are built as custom drivers that are required to run in real time within the Windows environment. WDM modem support can provide a common interface.

Software modems are one of the first computationally intensive services where third-party vendors are providing kernel-mode drivers that can have significant impact on operating system scheduling services. To assure reasonable system performance to the end user, this guide introduces performance guidelines for software modems.

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These guidelines are primarily meant to guide designers in the development of WDM-based software modem implementations. The instrumentation techniques suggested might not be applicable to industry standard external “black box” testing of modem performance.

Similar guidelines might need to be established for other services and drivers as support moves into kernel mode. As an example, DirectSound3D, DirectMusic, software MPEG, and AC-3 decoders for DVD are being implemented by some vendors as user-mode services.

Network Communications Design Issues

The Network Driver Interface Specification (NDIS) 5.0 represents a number of extensions to the interface described in NDIS 3.0 and 4.0. The basic requirements, services, terminology, and architecture of the earlier versions also apply to NDIS 5.0. The new NDIS architecture will be included in the Windows 98 and Windows NT 5.0 operating systems.

NDIS 5.0 consists of all functionality defined in NDIS 4.0, plus the following extensions:

- NDIS power management, required for network power management and network wake up.
- Plug and Play, which is now applicable to Windows NT 5.0 drivers.
- WMI-based hardware instrumentation support for structured, cross-platform management of NDIS miniports and their associated adapters.
- Mechanisms for off-loading tasks such as TCP/IP checksum, IP Security, TCP message segmentation, and Fast Packet Forwarding to intelligent hardware.
- Broadcast media extension, required for broadcast components.
- Deserialized miniport for improved performance on Windows NT multi-processor systems.

  Information about the miniport driver model is included in the Windows NT 5.0 DDK.
- Connection-oriented NDIS to support native access to connection-oriented media such as ISDN and ATM, including ATM/ADSL, ATM/cable modem, and so on, plus support for Quality of Server (QoS) when supported by the media.

  Previously, NDIS primarily supported network adapter driver development and deployment of connectionless network media such as Ethernet, Token Ring, ArcNet, and Fiber Distributed Data Interface (FDDI). NDIS 5.0 extends this interface to provide efficient support for connection-oriented media such as ATM (including ATM/ADSL, ATM/cable modem, and so on) and ISDN with isochronous data transfer for media that supports QoS. The new architecture also enables support for streaming multimedia data such as audio and video over the NDIS media.
- Intermediate driver support, which is required for broadcast components, virtual LANs; LAN emulation over new media such as ATM, satellite or broadcast television, and so on; packet scheduling for QoS; and NDIS support over WDM-supported buses, such as IEEE 1394 and USB.

The PC 99 guidelines also introduce home networking as a significant new area for design concerns, with different constraints than conventional networking. These guidelines introduce minimal standards for quality, with few technical standards, to allow time for the market to develop.

Scanner and Digital Still Image Device Design Issues

The integration of imaging devices on the Windows platform presents a wealth of business opportunities by transforming end-user computer interactions to those which are visually exciting and inherently more natural because of their visual nature. Contextual information can be conveyed as never before.

Changes in Windows 98 and Windows NT 5.0 address both consumer and business market segments with support for still image devices by providing broad, extensible operating system services. Imaging under the Windows platform will continue to grow to meet the challenging needs of the pre-press, publishing, and document imaging markets, as well as the burgeoning consumer market, by allowing for a range of possibilities from simple to complex.

For PC 99, new design issues make the PC the premier imaging platform. To accomplish this, hardware vendors need to seamlessly integrate their devices with Windows. Issues include designing ways to:

- Initiate workflow for the user, such as incorporating push model support in all imaging peripherals.
- Reduce the complexity of working with imaging devices by using operating system services where available. This allows a consistent user interface, simplifying steps in image acquisition, processing, and output.
- Ensure consistent color from acquisition to output by working with Windows Integrated Color Management (ICM), providing for a positive end-user experience.
- Integrate higher bandwidth peripheral connections with the PC for faster image transfer and better user experience. Peripheral connection should migrate from:
  - Legacy serial to USB
  - Serial IR (SIR) to fast IR (FIR)
  - Parallel to IEEE 1394
  - SCSI to IEEE 1394

PC 99 requirements for imaging devices set the state for future Windows imaging support. By complying with these design guidelines, the imaging IHV creates a better end user experience on the Windows platform and also readies its product lines for upcoming system services based on the operating system’s current building blocks.

Device Bay and Modular PC Design

Device Bay is a technology that enables adding and upgrading peripheral devices without opening the chassis and without turning off or rebooting the PC. Device Bay also enables peripheral devices to be easily swapped between platforms.

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The *Device Bay Interface Specification* is an industry specification co-authored, and jointly owned and managed by Compaq Computer Corporation, Intel Corporation, and Microsoft Corporation. To obtain the Device Bay specification, see the web site at http://www.device-bay.org.

The Device Bay specification defines an architecture that supports hot-swapping devices and the interoperability of peripherals and platforms. A bay can be built into the chassis of any PC system that meets the operating system requirements plus all the connector receptacle, bus interface, mechanical form factor, power, thermal, and controller logic requirements, as defined in the Device Bay specification.

Device Bay devices must use one or both of the industry-standard extensible bus interfaces: IEEE 1394 or USB. These buses provide a broad range of bandwidths and scalable performance to support the requirements of PC peripherals for at least the next five years.

Device Bay Device Categories. Device Bay provides manageability and interoperability for a range of PC peripherals and PC categories, including business, and consumer desktop and portable computers, as well as home-theater technology.

The Device Bay technologies support devices for mass storage, security, and communications and connectivity, and for a variety of other devices. Device Bay technology allows OEMs, retailers, and end users to easily add peripherals to support specific application needs. For example, an IEEE 1394 hard disk drive could be added to provide a large storage medium for digital imaging or audio authoring, a DVD drive could be added to enable DVD-Video playback, or a smart card reader could be added for secure online banking or shopping.

Device Bay technologies also support swapping a hard disk drive—and thus a set of data and applications—between a desktop system and a laptop PC. In the corporate environment, a hard disk drive could be removed from a failed system and inserted into a working system, minimizing employee downtime and lowering TCO.

PC 99 and Device Bay. Device Bay is recommended for PC 99 systems. The following features are required to implement Device Bay in a PC system design:

- One USB and one IEEE 1394 port for each Device Bay-capable bay in the system; power for the bay in compliance with the Device Bay specification; and a controller for the bay, which must be a Device Bay Controller, in compliance with the Device Bay specification.
- Peripherals that interface with either USB, IEEE 1394, or both. If a USB connection is used, it must support USB device class specifications.

PC 99 compliance testing for Device Bay is expected to begin January 1, 1999, subject to availability of hardware components. For complete requirements, see Chapter 3, “PC 99 Basic Requirements.”

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OnNow and ACPI Design Issues

The OnNow design initiative is a comprehensive, system-wide approach to system and device power control based on a group of new specifications. OnNow is the term for a PC that is always on and responds immediately to user requests or other events, but it appears to be off when not in use.

Since *PC 98 System Design Guide* was published, the following industry advances have been made on the OnNow design initiative:

- OEMs and system-board manufacturers have shipped ACPI-ready portable and desktop computers. They are working to make ACPI-compliant BIOS implementations available to their customers when ACPI-enabled operating systems are shipped by Microsoft.
- Advanced features of OnNow, such as wake-on-LAN, low-power desktop system boards, and PCI bus implementations that support wakeup from D3 (cold), are in development and being tested.
- The assembler, debugger, and compatibility testing tools provided by Microsoft have been finalized, enabling system manufacturers to design, develop, and test ACPI chip sets, firmware, and system boards.
- Implementation of the Windows user interface, device driver interfaces, application interfaces, and policy manager interfaces have been completed and documented.

The key design progress for OnNow and ACPI focuses on the following capabilities:

- Migration of system configuration from the Plug and Play BIOS to ACPI. ACPI leverages the Plug and Play BIOS data structures in a way that is compatible with both Windows 98 and Windows NT 5.0, but independent of processor architecture implementations.
- Migration of legacy power management from BIOS Advanced Power Management (APM) 1.2 to ACPI for Windows 98 and Windows NT 5.0.
- Device and device driver design for compatibility with OnNow operating systems.

Current information about specifications and progress for this initiative, including details for technical implementations, can be found on the web site at http://www.microsoft.com/hwdev/onnow.htm.

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Win32 Driver Model

The Win32® Driver Model (WDM) is designed to allow binary compatibility of for Windows 98 and Windows NT 5.0 drivers for targeted device classes. For bus and device classes with WDM support, driver developers write only small minidrivers to expose device-specific features.

The WDM core provided by Microsoft for Windows 98 and Windows NT 5.0 is a subset of Windows NT kernel services, with new cross-platform application programming interfaces (APIs) for Plug and Play, power management, and Windows management instrumentation. For each bus class and device class with WDM-based support, Microsoft provides a class driver, which is a device abstraction for a particular class of devices.

Microsoft provides the WDM core services, which are documented in the Windows NT 5.0 DDK and the Windows 98 DDK. WDM support for Windows 98 and Windows NT includes the following:

- USB and IEEE 1394 devices
- HID-compliant devices
- WDM digital audio
- Still and video imaging
- DVD decoding
- USB and driver-based software modems

Key support for many devices relies on the WDM Stream class driver, which optimizes data flow in the operating system kernel.

Manageability Initiatives

The purpose of the manageability initiatives described in this guide is to help plan, deploy, proactively maintain, and centrally control a distributed computing environment in order to reduce the overall cost of owning and managing computers. To do this, management technology must bring together information from different technology disciplines to provide services oriented toward management functions, which can in turn decrease TCO.

To succeed in significantly reducing TCO, management solutions must adapt to the needs and tasks of the environment to be managed. The solutions must therefore be open, flexible, and extensible: They need to support new technologies and integrate management functions supplied by more than one vendor. Such systems must conform to appropriate existing standards and have sufficient flexibility to extend support to emerging standards and technologies.

Providing management solutions requires establishing a management infrastructure in the operating system, exposing this infrastructure, and then building the tools to use it. This includes:

- Providing instrumentation as the infrastructure for manageability.
- Supporting management tools.
- Supporting new developments such as policy management in Windows 98 and Windows NT 5.0.
- Providing interfaces for enterprise management vendors.

For hardware platform designers, the technology used for platform instrumentation is of direct interest because it is a design element for their systems. Some earlier PC platforms were instrumented with the Desktop Management Interface (DMI), as described in the *Network PC System Design Guidelines*.

In the PC 99 time frame, new Windows management infrastructure components are requirements for Office and Workstation PC systems, and also for mobile PCs that come preloaded with Windows NT.

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